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ABSTRACT

This study analyzed 131 computer-generated graphics for evidence of emergent writing. Four preschool children created the drawings on a color and a black-and-white computer during eight weekly 1.5 hour sessions. Audio and videotapes were obtained to review procedures, language, and emergent literacy intent. Drawings were categorized independently by two coders into previously established phases of drawing and writing and subsequent subcategories. All three phases of emergent literacy were evident in the computer drawings with few representing a single phase. The categorization of the 131 computer drawings revealed that 80.9% of the graphics were in Category 1 (Scribble/Drawing), while 25 separate graphics, or 19.1% of the total, exhibited 33 emergent writing behaviors in phases II and III. Of these 33 emergent writing instances, 6.1% were in Category II (Representational phase). Category III (Object Representation) included data in these categories: (1) symbols for words, 9.1% (subcategory number 3); (2) strings of letters 33.3% (subcategory 4); (3) spelling of own name, 42.4% (subcategory 5); (4) spelling dictation, 9.1% (subcategory 6). There were no differences in the drawing/writing categories between black-and-white and color graphics. There were no age or gender differences. (Contains 2 tables, 2 figures, and 46 references.) (Author/SLD)

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TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

Preschoolers' Emergent Writing at the Computer

Paper Presented at the Annual Meeting of

The American Educational Research Association

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Preschoolers' Emergent Writing at the Computer

This study analyzed 131 computer generated graphics for evidence of emergent writing; four pre-school children created the drawings on a color and a black-and-white computer during weekly eight one-and-half hour sessions. Audio and videotapes were obtained to review procedures, language, and emergent literacy intent. Drawings were categorized independently by two coders into previously established phases of drawing and writing and subsequent sub-categories. All three phases of emergent literacy were evident in the computer drawings with few comprised of a single phase. The categorization of the 131 computer drawings revealed that 80.9% of the 131 computer graphics, were in Category I-Scribble/Drawing Phase, while 25 separate graphics, or 19.1% of the total, exhibited 33 emergent writing behaviors in phases II and III. Of these 33 emergent writing instances, 6.1% were in Category II-Representational Phase. Category III-Object Representation included data in the following Sub-Categories: #3-Symbols for Words, 9.1%; #4-Strings of Letters, 33.3%; #5-Spelling of Own Name, 42.4%; # 6-Spelling dictation, 9.1%. There were no differences in the drawing/writing categories between black-and-white and the color graphics. There were no age or gender differences.

Preschoolers' Emergent Writing at the Computer

The use of computers in early childhood classrooms and literacy instruction are two areas that have caused concern and controversy among educators of young children who support the idea that at this early age most learning is occurring through play in unstructured settings. Both the use of computers and the teaching of reading during the preschool levels have been regarded as highly structured and inappropriate for this age. Many consider such practices as possibly harmful to young children at worst and, at least, as waste of precious time that could be utilized for other more appropriate activities. Recently there has been a gradual change toward acceptance of both computer usage and literacy activities as result of modified practices and impact of research findings: Whole language, literature based practices are being widely embraced as acceptable instruction for children's literacy development through interactive, child centered activities. Also, computer usage with young children has recently been guardedly accepted by many early childhood professionals as a worthwhile practice with the stipulation that such activities be appropriate. However, early childhood settings remain susceptible to drill-and-memory literacy instruction and the perception remains of computers as cold, impersonal machines not consistent with the warm, supportive environments traditionally associated with early childhood classrooms. The discussion following addresses some earlier criticisms related to the use of computers and literacy instruction; included also are recent research findings related to computer usage as a tool for literacy acquisition. Lastly, findings are reported from a study that combined computer usage and emergent writing as a focus.

Early Criticisms of Computer Usage

Criticisms ranged to all areas of child development as reactions to the initial introduction of microcomputers into early childhood classrooms. Major critics focused on the isolating effects that computer usage might have on young children, lack of social interaction, computer activities with a narrow focus that would perpetuate inappropriate views of children's abilities, and possible over-emphasis on preparation for school at the expense of play and creativity (Kaden, 1990; Fein & Campbell, 1983, cited in Simon, 1985). These have not been upheld by findings reported in comprehensive reviews of the literature; on the contrary, these indicated positive results of computers as related to major areas of development and content areas (Clements, 1987; Clements & Natasi, 1993; Kaden, 1990). Another study (Kim, 1885) reported that instead of isolating children, computer competence contributed to social acceptance, willingness to share, and cooperative behavior. Other concerns not supported by research were that

traditionally accepted play based learning activities of early education classrooms and inclusion of activities that limit children to manipulation of two-dimensional abstractions of objects instead of the real objects themselves were potentially harmful (Cuffaro, 1984; Zajonc, 1984). Instead of limiting play, research reports that children used the computer as another medium for play ranging from exploratory to constructive and imaginary play as well as dramatic play (Escobedo, 1992; Fein, cited in Simon, 1985). The idea of the abstractions of computer symbols as harmful was also not supported. Much of children's activity is symbolic in that they use symbols in play, song, art, and language; if computer symbols are used in the same ways, then children may benefit from appropriate computer technology (Clements & Nastasi, 1993; Wright, 1994). Since the ability to create symbols to represent meaning is functionally associated with cognition, the use of computers during the early years, a time of rapid growth of symbolization, may be critically important to cognitive development (Hofmann, 1986). Thus, recent research seems to indicate that, when used appropriately, computers can be utilized with young children and may provide them the opportunity to acquire programming skills, serve as a means of promoting problem solving, creative thinking, and the ability to engage in symbolic representation (Escobedo & Bhargava, 1991; Goodwin, Goodwin, & Garel, 1986). Haugland & Shade (1990) contend that computers are neither good nor bad. They are only another educational tool, such as pencils, that can provide a unique way of dealing with information.

Literacy Instruction

From the earliest beginnings of early education curricula, the inclusion of structured language experiences and formal reading/literacy instruction has generated dissension. Historically, language and literacy experiences based on highly structured, drill approach have been criticized as inappropriate. However, such practices have remained evident in many early education settings due primarily to stress on academic achievement in school, escalation of the curriculum, and the pushing down of formal instruction into preschool classrooms. To counter this trend, The National Association for the Education of Young Children established guidelines to support quality education and defined specific appropriate practices for different developmental areas and developmental levels. Inappropriate practices specific to language and literacy are defined as those "Activities designed solely to teach the alphabet, phonics, and penmanship..." (Bredekamp, 1987, p. 6) and reading and writing instruction that stresses isolated skills such as correct letter formation as opposed to children having many reading experiences and "...experimenting with writing by drawing, copying, and

inventing their own spelling" (p. 55). Among others, the curriculum guidelines stress activities that engage children actively through a wide variety of learning experiences, materials, and equipment, and provide for development of children's thinking, decision-making, and problem solving (Bredekamp & Rosegrant, 1992). Dyson (1991) describes previous views of precursors to writing as solitary, quiet, and colorless. However, she focuses on the multiple worlds of children in which social relationships and much talk among children are viewed as critical to literacy development.

Computers and Literacy Acquisition

There is a scarcity of information in the literature on the impact of computers on emergent literacy. Some investigators have explored the possibilities of computer usage for writing for upper level students (Cochran-Smith, 1991; Sulzby, 1988). Studies related to computers and preschool children's emergent writing have only recently began to appear (Sulzby, 1992; Moxley, Warash, Coffman, Geres, Roman, & Terhorst 1994; Kelly & O'Kelly, 1993; Loar, 1992). Cochran-Smith (1991) also cites the relatively small body of literature concentrating on elementary school writers with the least information being about younger children which "is virtually nonexistent..." (p. 147). The few studies available report positive results: Loar (1992), from a study using a multimedia language arts program for children in pre-school through second grade, reported that computer writing increased children's attention span, concentration, and perception; satisfied their curiosity; provided them with discovery of organization in verbal material; and helped them to distinguish between graphic displays of objects and letters. Another study of prekindergarten students writing stories during the school year with pictures and names on a word processing program, reported that writings changed in productivity, complexity, and accuracy (Moxley, Warwash, Coffman, Geres, Roman, & Terhorst, 1994). Contrary to recent findings of play at computers (Escobedo, 1992), computer usage is often seen much as Dyson (1991) describes previous views of precursors to writing: solitary, quiet, and colorless. This passive view was refuted by Nastasi and Clements (1993) in a study of 24 first and 24 third grade students. They reported increases in children's motivation and social interactions including cooperation and collaborative efforts in computer environments. Though not reporting findings, Kelly and O'Kelly (1993) identified developmental approaches (emergent literacy and whole language) and classroom use of computers as two recent innovations making a major impact on education. They recommended further studies of writing contexts for young children in which computers can be used to best advantage as well as of type of

delivery device used; recommended are icon-based applications like those supported by Macintosh computers (Kelly & O'Kelly, 1993).

While there is some evidence in the literature of computer usage and related research at the elementary school level to aid in the development of writing skills (Cochran-Smith, 1991), as noted above, few studies concentrated on computer usage and literacy with younger children. This is especially true of children's transition from drawing to written symbols, emergent writing. Therefore, the purpose of this study was to examine the computer works of four preschool children in light of emergent writing. Specifically, this paper describes evidence of emergent writing, the nature of the graphics in terms of developmental phases of writing, and possible differential effects in the products produced on color and on black-and-white computers.

Theoretical Framework

This study was formulated on recent theories of language and literacy development, on developmental phases of drawing and writing, and on computer usage research. Children's literacy development begins early in life, when children first hear spoken language and then start producing sounds and symbols to communicate. This statement reveals a conceptual change regarding children's early literacy development that has taken place since the late 1960s when Marie Clay coined the term "emergent literacy" to describe the new view of literacy as beginning at birth and emerging continuously until the stage of conventional reading and writing is achieved (Clay, 1966. Cited in Dyson, 1991). Children's listening skills, oral language development, and experiences with reading and writing together form the basis for their emerging literacy. The new view of early literacy impacts all areas of literacy development so that children's initial attempts at reading and writing are viewed as "real" literacy behavior. The interrelated areas of listening, speaking, reading and writing are strengthened by meaningful experiences which play a vital role in the acquisition of literacy. The addition of reading and writing materials into the homes and classrooms of young children, along with developmentally appropriate experiences for using them, strengthen children's literacy experiences. Because computers are rapidly becoming commonplace in the homes and families of children today, along with the traditional reading and writing materials, it seems appropriate to add this new technology to children's classroom experiences to aid literacy development.

Drawing and Writing:

Symbolic representation has been an area of interest to early childhood educators long before computers became part of children's lives. The ability to create symbols and thereby convey meaning by referring to a thing, an idea, or feeling, allows humans to become familiar with their environment and to communicate their knowledge (Werner & Kaplan, 1963). In this way, artists and writers, through pictures or words, share their knowledge and feelings with others. How then does this development of representation occur in children? The development of representation in children has been described as evolving in various stages from knowing that objects exist, to identifying and recreating objects, and finally to advanced phases of depiction such as writing (Werner & Kaplan, 1963). Dyson (1991) noted that children explore and use all the symbolic material available to them: language, constructive media, play, and drawing and painting to create pictorial symbols.

L. S. Vygotsky (1978), the Russian psychologist, located the prehistory of written language in children's drawing and playing and claimed that in play, children used some objects to denote others, replacing them and becoming signs for them. Vygotsky believed that this was the key to the entire symbolic function of children's play-- that the child's self-motion, his/her own gestures, were what assigned the function of sign to the object to give it meaning. From Vygotsky's point of view, then, children's early symbolic play is understood as a very complex system of speech through gestures that communicate and indicate the meaning of playthings. However, as children get older, they make the important discovery that objects can indicate the things they denote as well as substitute for them. Therefore, in play with objects, representation of meaning is initially "first-order symbolism". When the object acquires a sign function of its own, independent of the child's gesture, it becomes "second-order symbolism" (1978, p.110). Because the second-order symbolism develops in play, Vygotsky saw make-believe play with objects as a major contributor to the development of written language, which he deemed a system of second-order symbolism. Thus, through their written language, children graphically represented their experiences, using lines and curves to name their world. As in play, these first written signs of children are entirely first-order symbols, directly denoting objects or actions; later, children move on to second-order symbolism, involving the creation of written signs for the spoken symbols of words. In doing this, stated Vygotsky, the children make a basic discovery--that they can draw not only things but speech as well, leading children to letter writing. Thus, "the written language of children develops in this fashion, shifting from drawing of things to drawing of words" (Vygotsky, 1978, p. 115).

The study of how children develop as artists and as writers holds great interest for many researchers and educators. Feinburg (l993), characterizing how art develops, states that artistic expression follows a predictable sequence, shifting and changing in a fluid fashion as children grow. Toddlers, two-and three-year-olds are characterized by making marks and discovering forms to create non-objective art which represents a feeling or mood rather than a particular object. Older three-and four-year-olds engage in early symbolic work and are increasingly concerned with using form to create "real things." Five-and six-year-olds are characterized by an increasing desire to create realistic art.

Although some researchers have stated that drawing is a form of prewriting and part of the communication process of composing written languages, others such as Newkirk (1989) dispute the claim that drawing is merely a rehearsal for writing and state that drawing is as important to young children as writing and that for them, drawings, text, and verbalizations together constitute writing. Other researchers in the emergent literacy field have examined many aspects of young children's written language development to analyze how they figure out how the written language encoding system works--how their speech is mapped onto written symbols (Dyson, 1983; Ferreiro, 1986; Read, 1986). Vulkevich (1992) studied children's understanding of the functions of writing during play, and added that discovering how a child integrates the functions of writing into his/her play requires more than collecting writing samples. Writing samples without a record of the child's oral language during play tells little about the child's understanding of writing functions. Some researchers have observed and characterized the three stages of development children go through in learning to write. These emergent drawing and writing stages are the scribble, the representational, and the object representation phases as described below. (Clay, 1987; DiLeo, 1970; Sulzby, 1986; Wolfe & Perry, 1989).

The Scribble Phase:

As soon as the baby can physically hold markers and move them across a surface, about twelve months old, the onset of scribbling begins. Rampant explorations and purposeless markings constitute these early markings (Wolfe & Perry, 1988; Clay, 1987). DiLeo (1970) identified these early kinesthetic motions as non-communicative, muscular movements and actions, with the motoric activity itself providing the satisfaction. At about fourteen months, the child may demonstrate gestural representation such as "hopping" the marker across the paper like a bunny, saying "hop, hop, hop." At about twenty months, the child may be capable of recording the

number or location action of an object's features, such as drawing a person by making one pencil mark for the head, a lower slash for the tummy, and two slashes for the feet, thereby producing point-plot representation scribbles. The readable graphic scribble becomes evident between eighteen and thirty months during which time the child may create a scribble-blob on a paper and call it "doggie in the car." The drawing, lacking visual similarity or evidence of any kind, is the total result the child's perception and accidental associations (Wolfe & Perry, 1988).

The Representational Phase:

Deliberate attempts to make something with markers on paper marks the onset of the representational phase and the beginnings of symbolic representation. DiLeo (1970) described the stage as an extension of motor play and agreed with Piaget to state that the child draws what he knows, not what he sees. Thus, the child begins to crudely represent the things that he knows in real life or in books (Clay, 1987). It is during this phase, about three years of age, that the child begins to differentiate between drawing and writing (Dyson, 1982). Although no one knows exactly how or why the child begins to make the distinction, DiLeo explained the processes as " two forms of graphic activity, related but different in origin--the first expressive, the other communicative--are both valuable indices of the child's psychological development" (1970, p. 143). In writing, children produce horizontal line streamers, marks in lines resembling conventional printing, and eventually shapes that begin to approximate letters. In drawings, figures and shapes are repeated and elaborated.

The Object Representation Phase:

In this phase, approximately five to seven years of age, drawings and writings are approximating adult models and are somewhat recognizable but are produced as representations and not reproductions of what the child sees. In writing, letters are randomly spaced about the page often prompting the child to ask the adult to read what has been written on the paper. Later, children pretend to read the letters and verbalize messages which only they can read. As the child becomes aware of words, he/she may produce symbols that stand for words and use them as labels for things. Prior to recognizable words, the child may also produce strings of letters indicating awareness that words are comprised of a variety of letters. One of the first words generally attempted by children is the writing of their own names followed by variations and the writing of other people's names. Believing that early writing is graphic symbolization and not letter/sound correspondence, Clay (1975) stated that the markings do not

represent utterances, but objects and events. As the writing becomes more literate, resembling adults' reading and writing more closely, the onset of the transition becomes more evident with higher level activities. Invented spelling surfaces as children attempt to write messages from the sounds they know, copy lists of words, and write stories independently. Drawing in this object representation phase also begins to be recognizable, for the child begins to pay more attention to placement, scale, precision, and realism; with increased maturity, the child produces more approximate detailed reproductions similar to adult models.

Computer Drawing

Investigators from various areas have explored the possibilities of computer usage for drawing for young children (Beaty & Tucker, 1987; Escobedo & Bhargava, 1991) and for writing at the elementary grade levels (Cochran-Smith, 1991). However, studies related to computer usage for preschool emergent writing are scarce despite the fact that some software programs suitable for young children are available ranging from word processing to drawing programs with text capabilities (Clements, 1987). One study using drawing programs found that children moved from experimenting with the machine's responses to carefully planned symbolic representations followed by explanations of the procedures (Church & Wright, 1986). Some researchers believe that the benefit of using computers may be in providing needed support or scaffolding for young writers (Clements, 1987; Rosegrant, 1986. Cited in Clements, 1987). With such scaffolding, children may experience fewer fine motor control problems and will write more, feel less worried about making mistakes, but will feel increased pride in their writing because the text looks better (Clements, 1987; Phenix & Hannan, l984). Other researchers have reported that computers enhance other expanding symbolic systems such as language, pretend play and counting (Beaty & Tucker, 1987; Escobedo, 1992). Sulzby, (1988; 1992) investigated children's writing on and off the computer in a project called Computers in Early Literacy (CIEL) and found that children demonstrated emergent behaviors in both reading and writing with the computer, but the design of the software clearly influences the forms with which the children write. In addition, some software programs that provide the equivalent of paint and brush activities, allow children to create pictures and designs from scratch and to use computers for symbolization in a manner similar to other art media (Sheingold, 1986; Escobedo & Bhargava, 1991). However, since much is not known about the impact of computers on children's emergent writing, it is timely to study children's computer generated graphics in terms of evolving drawing-writing phases and to transcribe and study the oral

language produced during the emergent writing. Only actual examples of children's work and language will provide the much needed information related to the use of this new technology in an important area of development.

Study of Emergent Writing and Computers

Questions of Study:

This study emerged from a larger study that investigated children's computer graphics in terms of stages of art and symbolic representation (Escobedo & Bhargava, 1991). Early in the data collection phase, the researchers noted evidence of emergent literacy behaviors as the children manipulated the computer to produce their computer graphics. In the original study, categories of developmental stages of art were based on the work of Mayesky, Neuman, and Wlodkowski (1985) and included Scribble Stage, Basic Forms Stage, and Pictorial Stage. However, initial analysis of this data revealed the need to add a fourth category, Nondrawings, for graphics that consisted mostly or totally of letters and numbers produced as a result of children's experimentation with the keyboard. It was this nonpictorial category that revealed emergent literacy behaviors and prompted further study by researchers.

Based on this orientation, investigators examined the computer graphics and related language episodes for the present study in order to analyze the drawings in terms of emergent literacy. Thus, the research questions addressed were: What evidence of emergent writing is exhibited in the computer generated graphics? What is the nature of the children's graphics in terms of developmental phases of writing? What differential effects were evident in the products produced on the color and the black-and-white computers? To answer these questions, a descriptive design was utilized. Certain parameters (a framework based on the emerging phases of writing) were devised from which to view emergent writing behaviors and related language episodes (See Table 1).

Methods and Procedure

The laboratory type setting included a color-monitor Apple IIGS computer with color monitor utilizing a Paintworks Plus (Version Soft, Inc., 1986) software program and a black-and-white Macintosh SE with MacPaint (Atkinson, B., Kaehler, C., & Mok, C., 1983) to produce the drawings. Both computers used the mouse attachment to manipulate the cursor on the screen and to activate the software menus. The two software programs used were exactly the same in terms of available menu, procedures, and icons except that Paintworks Plus contained 16 color and 16 visual choices while

Table 1

Classification of Emergent Literacy Categories

Drawing	Writing
I. Scribble Phase	
Scribbling with intent to draw	Scribbling with intent to write
II. Representational Phase	
Basic Forms	1. Print Resemblance Horizontal lines & marks, streamers Simple Approximations signs, letters
III. Object Representation	2. Random Placement of Letters Messages-Non-intended, ask for reading of message Messages--Intended--pretend read 3. Symbols for Words- (Word awareness) symbols & labels for things 4. Strings of Letters- random selection, repeated patterns 5. Spelling Own Name, variations of own name; others' names 6. Spelling Words--incomplete & missing letters; dictation

MacPaint offered 36 patterns but no color. These software programs were selected because of their simple, iconic menus and their freehand drawing capabilities. Care was given to their developmentally appropriateness such as open-endedness that placed computer control with the children so they were able to create their own products as opposed to drill activities. Software is the key to computer appropriateness (Haugland & Shade, 1990). In addition, the setting included a drawing table arranged with concrete art materials.

The primary sources of data for this descriptive study were produced by four middle-class children, two males (a 4-year-old and a 5-year-old) and two females (a 4-year-old and a 5-year-old). The children had no prior exposure to Apple computers or to the mouse attachment. They had limited experience with computers at their preschool using software that provided ready-made graphics but no freehand capabilities. Data collection occurred during eight 90-minute sessions, one per week, in an observation room at the University of Texas, College of Education. Videotapes were made of the activity at the computers and art table; also, videotapes were obtained of the children's work by directly connecting the Apple IIGS computer to a video recorder and a microphone. Thus the language and total procedure used to complete the drawings at this computer were recorded. The activity at the Macintosh was audiotaped; and observer field notes were kept of activity surrounding the computer area. Careful documentation was kept of the process that took place at the art table with traditional art materials; the child's language and/or labels were recorded on the back of each depiction. (Results of art table reported separately-in progress) Four researchers were involved in collecting the data and writing notes after each session: One functioned as main teacher conducting the group instruction and supervising the activity at one computer; one supervised the other computer; one monitored the art table; and one observed and took field notes.

A child-centered, guided-discovery approach was used to introduce the children to art activities and computer usage. No specific tasks were required. It was expected that the children would initiate their own graphic work through play experimentations and would manipulate the computer to create their own art works, much as they would with concrete art materials. This assumption was based on assertations that children's acquisition of skills in Logo is conditional upon discovery learning that allows the development and exploration of self-initiated projects (Papert, 1980). Weekly lesson plans based on broad topics, formulated prior to the study and modified as needed, guided the general direction of instruction for the sessions. Topics covered were scribble, shape, and pattern tools; erasers and background; borders; overlapping;

texture; and storage and memory capabilities. The lessons included hands-on demonstrations to introduce the children to the computers' capabilities and to functions of the software menus; art concepts such as color, shape, background, overlapping, and actual and visual texture were also included.

Data Analysis

The data included 131 computer-generated graphics saved on diskettes and printed on hard copy, 36 hours of videotapes, 12 hours of audiotapes, and extensive observation and field notes. Preparation of data prior to analysis included transcribing the audio and video tapes, and entering the data into a word-processing file. Two coders independently reviewed and categorized the drawings from both computers. Interrater agreement was established at the 95% level of agreement. The coding scale used was based on the work of several researchers with categories including the three hierarchical phases in emergent drawing and writing, identified and organized as the scribble, the representational, and the object representation phases (Clay, 1987; DiLeo, 1970; Sulzby, 1986; Wolfe & Perry, 1989). The scribble phase category has the same characteristics for drawing and writing, although for this study, the scribble category was modified to reflect intent to draw or intent to write. The representational and object representation categories have drawing and writing sub-categories with distinct characteristics for each. For this study, the three hierarchical categories were expanded to include six well-defined sub-categories: (1) Print Resemblance and Simple Approximations; (2) Random Placement of Letters; (3) Symbols for Words; (4) Random Strings of Letters or Repeated Patterns; (5) Spelling of Name and Others' Names; and (6) Spelling Words On Own or From Dictation. Interrater agreement by coders was 98% level of agreement. The verbal transcriptions were checked against field notes and videotapes to coordinate the language and actions of the children with the action on the computers. These were then coordinated with the proper computer generated drawings. Black-and-white photo copies were obtained for all of the computer generated drawings in order to standardize the data by eliminating color which might have been distracting to the coders.

To answer the first question--"What evidence of emergent writing is exhibited in the computer generated drawings?"--computer-generated graphics (75 black-and-white and 56 color) were reviewed. Graphics showing evidence of emergent literacy behaviors were analyzed in depth and categorized into the previously established phases and categories of drawing and writing. Segments of the video and audio tapes related to specific computer generated graphics were selected to establish

representation intentions, as evidenced in the children's language, and to differentiate between the possible phases.

To answer the second question--"What is the nature of the children's graphics in terms of developmental phases of writing?"- -the three expanded hierarchical categories were examined. For the third question--"What differential effects were evident in the products produced on the color and the black-and-white computers?"--graphics from the color-monitor Apple IIGS were compared with graphics from the black-and-white Macintosh SE.

Results and Discussion

An analysis to determine evidence of emergent literacy behaviors of the total computer graphics produced by the children on both computers (Question 1) showed that of the 131 computer graphics, 80.9% were in **Category I-Scribble/Drawing Phase**, while 25 separate graphics, or 19.1% of the total, exhibited 33 emergent writing behaviors in phases II and III. The language episodes associated with these graphics were also analyzed to reveal the nature of the graphics (Question 2). Results (See Table 2.) showed that of these 33 emergent writing instances, 6.l% were in **Category II--Representational Phase**, Emergent Writing Sub-Category #1--Print Resemblance and Simple Approximations. This category was characterized by horizontal lines and marks, streamers, and approximations for use as signs or letters. Although most of the literacy behaviors were created with the keyboard and therefore did not yield approximations but the actual printed letters, a small %age of the time one of the children attempted to create cursive letters without the keyboard. She initiated a series of controlled scribbles, using the mouse, clearly with intent to write. With practice, these scribbles yielded print resemblance.

In the **Category III--Object Representation Category**, no evidence of Emergent Writing Sub-Category #2--Random Placement of Letters was noted. This is probably due to the nature of the computer versus freehand writing with more traditional literacy tools such as paper and pencils. Use of the keyboard produces letters in strings or rows rather than in random placement. However, 9.1% of the 33 total emergent writing behaviors recorded were in Sub-Category #3--Symbols for Words in which word awareness was obvious. Symbols and labels for things were present.

Sub-Category #4, Strings of Letters with random selection and/or repeated patterns, made up 33.3% of the total. The largest sub-category recorded, and believably so, was **III--Object Representation** Sub-Category #5, Spelling of Own Name, variations of own name, and others' names. This totaled 42.4% of the emergent

writing behaviors recorded. These last two findings, (of Letter Strings and Names) are supported by earlier reports (Clay, 1987; Sulzby, 1986) that prior to recognizable words, the child may produce strings of letters indicating awareness that words are comprised of a variety of letters. Also, one of the first words generally attempted by children is the writing of their own names, followed by variations, and the writing of other people's names.

The last group of behaviors came from Sub-Category # 6--Spelling Words, incomplete/letters missing or words spelled from dictation--which exhibited 9.1% of the total 33 instances of emergent literacy behaviors. In this sub-category, words of environmental awareness were noted such as STOP, GUM, and LOVE.

A comparison of output from the Macintosh SE (black-and-white) and the Apple IIGS (with color) revealed the %ages of the writing behaviors produced on each (See Table 2). Although a greater number of graphics were produced on the Macintosh SE, a higher %age of graphics demonstrating literacy behaviors were produced on the Apple IIGS. This can be interpreted to mean that color had somewhat of an impact on the children's emerging writing behaviors (Question 3). Of the 56 creations on the Apple IIGS, 19 emergent literacy behaviors were noted; of the 75 graphics created on the black-and-white Macintosh SE, there were 14 emerging writing behaviors. To consider the total literacy behaviors as shown on Table 2, of the 33 noted emergent literacy behaviors, 57.6% were made on the Apple and 42.4% were made on the Macintosh. While this evidence shows a slight preference for work with color over black-and-white, these results should in no way be construed to mean that emergent writing will necessarily occur more readily or in greater quantity if color is present.

An analysis of the total descriptive data and the computer graphics indicated a display of children's computer emerging literacy behaviors that reflected emergent writing sub-categories in the representational and object representation phases as well as in the scribble/drawing phase. Considering the ages of the children, four-and-five-years old, and the emergent writing progression suggested earlier in this paper, the children in this study demonstrated a desire to write and progressed at a natural pace for their ages. This is evidenced by the fact that the majority of their literacy behaviors were in Sub-Categories IV and V, Strings of Letters, with random selection and/or repeated patterns; and Spelling Own Name, Variations of Own Name and Others' Names. In addition, a much greater percentage of the total computer graphics reflected the scribble drawing writing phase. This followed the emergent writing process: from scribbles, to letters to words (Sulzby, 1992). Drawings included scribbles with intent to

Table 2

Classification of thirty three emergent literacy behaviors by sub-category and computer

Sub-Category	Apple	Macintosh	Total Behaviors	%
II Representational Phase				
I. Print Resemblance	2	0	2	6.1%
III. Object Representation				
2 Random Placement	0	0	0	0
3. Symbols for Words	0	3	3	9.1%
4. Strings of Letters	7	4	11	33.3%
5. Spelling Own Name & Others' Names	8	6	14	42.4%
6 Spelling--Words	2	1	3	9.1%
Totals	19 (57.6%-color)	14 (42.4%-black/white)	33	100%

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write; most were pictorial evidencing the various stages of art (Escobedo & Bhargava, 1991).

An examination of the language transcripts and graphics served as further evidence of both a desire to write and as examples of the various emergent writing categories. The following language transcript and related graphic, of four-year-old Leila and her Teacher, exhibit the Representational Phase, Sub-category #1 Print Resemblance-lines, marks, streamers, and Object Representation, Sub-category #5, Spelling Names-own and others. (See graphic in Figure 1).

Leila: **I'm ready to use the tool.**

Teacher: **The text? That's the text tool. How about if we use the hand to move the drawing window up so you have space to use the text tool. If you want to use the text tool we have to bring the keyboard over to do some typing. First we need to move the mouse out of the way and get. Where do you want to type, Leila?**

Leila: **Up here.**

Teacher: **Up here is the space. (Teacher instructs Leila on how to use text tool.)**

Leila: **How do I write Polly?**

Teacher: **Polly --begins with the letter P. The next letter is O. What makes the "l" sound in Polly?**

Leila: **L.**

Teacher: **O.K.. Can you find L on the keyboard, Leila?**

Leila: **And another L?**

Teacher: **Two L's. That's right and the "e" sound is made by the letter Y. There you go. That spells Polly. H N K L B G H T Y You're making lots of letters. Watch the screen so you can see when you need to use the mouse to move the arrow. You can click again and you can type some more.**

Leila: **I did.**

In another session with the same participants the child gives evidence of Object Representation, Sub-category #4 Strings of Letters, and of Sub-category #6 Spelling Words-from dictation. (See graphic in Figure 2).

Teacher: **Leila, now you have a turn at the Apple computer.**

Leila: **Bla, bla, blo, bla. I want to type.**

Teacher: **You want to type. What do you have to do so you can type? Remember? Your cursor's flashing. Can you type with the mouse or do you need something else to type with?**

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POLLYJHNKLBGHTYUJIKXAZSAQWRRFFVT

Figure 1. Examples of Representational Phase, Sub-category #1 Print Resemblance-lines, marks, streamers, and of Object Representation, Sub-category #5, Spelling Names-own and others.

XHGFLHJZHNLHGKHGWUYZHIOGLURWUHG
DFERTGHYBNCVBNMJHUUYFGGHYGHJFHN
JGGGGBHNGVFCBBYTYBGJSTOP

Figure 2. Examples of Object Representation, Sub-category #4 Strings of Letters, and of Sub-category #6 Spelling Words-from dictation.

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Leila: I need something else.

Teacher: What do you need? The keyboard. O.K. Then, turn it very carefully around.

Leila (whispers and types). . .

Teacher: You typed some letters. (Teacher names the letters Leila's typing)

Leila: Look at all that.

Teacher: You made another line of letters. You have 2 lines of letters and numbers now. Looks like you're going to make a third line. (Leila laughs!). . .

Leila: I'll write stop right at the end.

Teacher: You can write stop. Do you want me to help you write that?

Leila: No, I know how to write it.

Teacher: You know how, when you write stop.

Leila: S T O P (Leila spells stop to the teacher)

Teacher ...Here you go. I'm glad that you're remembering to press the keys one at a time Leila. Looks like you're running out of space. Are you ready to spell STOP?

Leila: Hm hm.

Teacher: O.K. Can you find the letters that you need?

Leila: Yeah--S T O P. (Leila types STOP)

Conclusions and Implications

The purpose of this study was to investigate the nature of children's computer drawings in terms of stages of emergent literacy and writing. The findings reported above provide answers to the questions posed. First, the computer generated graphics exhibited evidence of emergent drawing and writing in all three broad developmental stages of art and writing, scribble phase, representational phase, and object representation phase. The representational and object representation phases were studied more closely to reveal six sub-categories of emergent writing beginning with print resemblance and ending with the spelling of words, with the majority of the writing behaviors falling in the typical four-and-five-year-old categories of strings of letters and spelling own and others' names. This indicates that appropriate computer experiences can provide children the opportunity for artistic and writing development similar to that provided by concrete art and writing materials. A comparison of output from the Macintosh SE black-and-white computer and the Apple IIGS with color revealed that although a greater number of graphics were produced on the Macintosh SE, a greater %age of emergent writing behaviors were produced on the Apple IIGS. This can be interpreted to mean that color may have had a motivational effect on the children, thus

resulting in greater experimentation with the color computer and hence further exploration with the keyboard when using the Apple than when using the Macintosh.

Although all of the children used the computer as a symbolic medium regardless of age or drawing/writing stage, more detailed drawings were created by the older children. Their associated language was also more elaborate. However, it was one of the youngest children, Leila, that exhibited the largest %age of emergent writing behaviors. Perhaps the older children had superior fine motor skills and could command pencil and crayon tools to write their names at will; because Leila could not, she felt empowered and thereby motivated to write with the keyboard. She attempted to write cursive print twice without the keyboard, but all other attempts to produce print came through the use of the keyboard. This did not hold true, however, for her counterpart, the younger male, Walter, who produced only two graphics with evidence of emerging writing behavior. Thus it would seem that writing at the computer may depend upon individual orientation rather than age alone.

In determining sex differences for emergent writing behaviors at the computer, the data revealed the production of writing behaviors as follows: Of the 33 emergent literacy behaviors recorded, Kiah produced 24.2%; Leila produced 42.4% for a total of 66.8% for the girls. Jeremy exhibited 27.2% of the recorded literacy writing behaviors; Walter produced 6% for a total of 33.2% for the boys. Although there seems to be a discrepancy by sex for total production of writing behaviors, at further study one may note than the older boy, Jeremy, and the older girl, Kiah, produced a similar amount of literacy behaviors with only 3% of variance. Therefore, it can be inferred from this study that neither sex nor age can be used to predict children's ability at emergent writing at the computer.

The descriptive nature of this study prohibits generalizations. However it can be inferred that children can use computers in playful ways while learning its functions when allowed to interact with the machine in a child-appropriate manner. It can also be inferred that children can develop as writers with the computer in much the same way as they can with traditional literacy materials. Important for teachers is the implication that developmentally appropriate strategies are needed for children's computer usage. This includes selecting and implementing developmentally appropriate software, experiences and activities. Also, teachers should provide sufficient time for implementing the program and for scheduling time for children to explore the capabilities of computer and software programs in order to learn to use them. The 1:1 adult-to-child ratio provided in this study cannot be implemented in the classroom. However teachers

should be aware that children need guidance as well as freedom when learning to use and interact with computers.

Due to the limited research on computers and young children, especially as related to emergent literacy, there is a need for further study in this area. This study used a laboratory type setting and an observational, descriptive design; thus it would be useful to investigate whether children in a natural setting would evidence the same interest and invest the same amount of time at the computer as did the children in this study. There is a need for further quantitative analysis of the graphics from this study to determine significant differential effects. Also needed are other studies of sufficient sample size to investigate computer effects on children as related to curriculum and developmental areas.

It can be inferred from this study that young children, in learning to use computers, depend on guidance from skilled leaders, and social interaction with others in the same ways as when learning with any other new medium. Computers can provide the same opportunities for language usage as any other childhood setting; and language at computers can provide information about children's thinking and literacy producing behaviors. The differences between appropriate and inappropriate computer activities may be the degree of freedom allowed the children for exploring and playing around with the computers in order to perform at their own levels. The software selected as well as the teacher's approach may be major factors contributing to the freedom necessary to learn at computers. Therefore, care should be taken to select open-ended software containing various levels of ability and various menu functions, from freehand tools to ready-made symbols, to allow children to develop their own capacity for self-expression. Adults should strive to maintain an atmosphere conducive to aesthetic responses and sensory experiences and should exhibit positive, encouraging attitudes in guiding children's computer activities. Only when all of this is done can an appropriate determination be made about the effects of computer usage with young children.

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